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(54) ENVELOPED-NEUTRAL-TYPE, LOW-VOLTAGE ELECTRIC CABLES

(71) We, DELTA ENFIELD CABLES LIMITED, formerly Enfield-Standard Power Cables Limited, of Millmarsh Lane, Brimsdown, Enfield, Middlesex, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to low voltage cables designed to operate at phase-to-phase voltages of up to 1000 volts in so-called protective multiple earthing (PME) systems in which the neutral conductor is also used as an earth continuity.

In such cables, the conventional four core arrangement may be replaced by an arrangement consisting of three cores enclosed within either a single concentric neutral conductor in the form of a metallic sheath, or within multi-enveloped neutral conductors or wires as in the case of an armour, over the insulated cores. The form of concentric neutral conductor will depend on the type of insulating material used for the phase conductors. The neutral conductor is protected by an outer sheath.

For such cables to be employed in a PME system, it is necessary to satisfy the following requirements:

(a) Conductivity of the neutral conductor or conductors should preferably be the same, and in any case must not be less than 50% of that of the phase conductor.

(b) The integrity and continuity of the neutral conductor must be preserved.

(c) The cable design must be such as to permit easy connection to a service cable without severing the phase and neutral conductors when the cable is electrically alive, and

(d) Accessibility and easy identification of phase conductors must be provided for.

The present invention in its preferred form provides a multi-core enveloped-neutral-type low voltage electric cable for PME systems which meets the above conditions whilst being of compact construction.

According to the present invention, there is provided an envelope-neutral type, low-voltage electric cable comprising three individually insulated phase conductors of diamond-shaped cross-section having two opposite angles of 60° and two opposite angles of 120° each, which are laid up helically so that their combined cross-section throughout the length of the cable is hexagonal, six neutral conductors laid up helically with the same pitch as the phase conductors and arranged in pairs with the neutral conductors of each pair lying respectively against the two outwardly facing surfaces of a corresponding one of the insulated phase conductors, a winding of metal tape applied around the assembly constituted by the phase conductors and the neutral conductors and in electric contact with at least four of said neutral conductors throughout the length of the cable and a sheath of flexible electrically insulating material enclosing the said assembly and the tape applied around it.

Each of the neutral conductors preferably has, on that side thereof which is applied against an outwardly facing surface of the corresponding phase conductor, a flat surface of substantially the same width as the said outwardly facing surface and, on the opposite side, a part-cylindrical surface the centre-line of which is co-axial with the centre-line of the cable. Consequently the assembly around which the metal tape is wound has a cylindrical outer surface.

The phase conductors, the neutral conductors and the metal tape may be of aluminium, while the insulation around each phase conductor and the external sheath may consist of an elastomeric plastics or other like material.

To facilitate phase identification, one conductor of each pair of neutral conductors corresponding to two of the phase conductors may be individually coloured with a

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corrosion-inhibiting paint, in which case the insulation of all three phase conductors can be of the same colour, e.g. black.

The metal tape, which may be helically wound over the six neutral conductors with a small gap between successive turns, may serve not only for providing electrical connection between all six, or at least four of the neutral conductors if the other two are coloured with a corrosion-inhibiting paint, but also for providing mechanical protection.

The construction of the cable according to this invention also has the advantage that the phase conductors are readily accessible without the need for severing the neutral conductors.

Furthermore, the three phase conductors and the six neutral conductors of this cable are laid up to give most effective utilisation of the space inside a circular cable.

Finally, with six separate neutral conductors as described above, the integrity and continuous earthing of the whole system is preserved.

The invention will now be described by way of example with reference to the accompanying drawing which shows a cross-section of a preferred form of the cable according to this invention.

Referring to the drawing, the cable shown is a three-phase cable having phase conductors 1, 2 and 3 of diamond-shaped cross-section. The phase conductors 1, 2, and 3 which are made of solid aluminium, correspond respectively to the three phases. All three conductors are provided with insulation as shown at 4. The combined cross-section of the three phase conductors is substantially hexagonal. Three pairs of neutral conductors 1A 1B, 2A 2B, and 3A 3B, which are also made of solid aluminium, correspond respectively to the three phases along the whole length as they are wound with the same pitch of lay as the phase conductors. Any one of the two neutral conductors of any two of the three phases may be coloured, e.g. painted with a corrosion-resistant coloured paint, for identification of the corresponding phase conductors.

The three phase conductors and the six neutral conductors are laid up with a suitable pitch (for example 1.3m) and assembled by means of a helically wound aluminium tape 5 so as to ensure continuous mechanical and electrical protection.

An outer sheath 6 of a plastics or elastomeric material is provided around the cable.

In order to make a service branch or T-joint from any of the phase conductors 1, 2 or 3 of the cable, owing to the choice of pitch during laying-up, it is easy to displace the two neutral conductors from the phase conductors over a certain length without severing them. Owing to the fact that there are six neutral conductors continuity may be preserved even if one or two neutral conductors were severed. It is also easy to identify the phase required. The phase conductor may then be exposed as necessary to make the T-joint.

WHAT WE CLAIM IS:—

1. An enveloped-neutral type, low voltage electric cable comprising three individually insulated phase conductors of diamond-shaped cross-section having two opposite angles of 60° and two opposite angles of 120° each, which are laid up helically so that their combined cross-section throughout the length of the cable is hexagonal, six neutral conductors laid of helically with the same pitch as the phase conductors and arranged in pairs with the neutral conductors of each pair lying respectively against the two outwardly facing surfaces of a corresponding one of the insulated phase conductors, a winding of metal tape applied around the assembly constituted by the phase conductors and the neutral conductors and in electric contact with at least four of said neutral conductors throughout the length of the cable and a sheath of flexible electrically insulating material enclosing the said assembly and the tape applied around it.

2. A cable as claimed in claim 1 wherein each of the neutral conductors has, on that side thereof which is applied against an outwardly facing surface of the corresponding phase conductor, a flat surface of substantially the same width as the said outwardly facing surface and, on the opposite side, a part-cylindrical surface the centre-line of which is co-axial with the centre-line of the cable.

3. A cable as claimed in any of the preceding claims in which the phase conductors, the neutral conductors and the metal tape are of aluminium.

4. A cable as claimed in any of the preceding claims, in which the insulation around each phase conductor and the external sheath are of an elastomeric plastics material.

5. A cable as claimed in any of the preceding claims in which one conductor of each pair of neutral conductors corresponding to two of the phase conductors is individually coloured with a corrosion-inhibiting paint for phase identification.

6. A cable as claimed in any of the preceding claims in which the metal tape is helically wound over the six neutral conductors with a small gap between successive turns.

7. An enveloped-neutral type, low-voltage electric cable substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*